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NATIONAL DAM SAFETY PROGRAM. BEAVER DAM (NJ00077), DELAWARE RIV--ETC(U)
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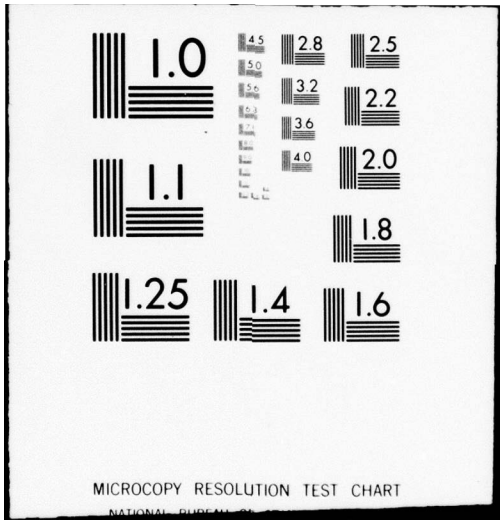
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BUCKSHUTEM CREEK
CUMBERLAND COUNTY
NEW JERSEY

BEAVER DAM
NJ 00077

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Approved for public release;
distribution unlimited

DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

April, 1979

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REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: NJ00077
2. GOVT ACCESSION NO.:
3. RECIPIENT'S CATALOG NUMBER:

4. TITLE (and Subtitle): Phase I Inspection Report
National Dam Safety Program
Beaver Dam
Cumberland County, N.J.

5. TYPE OF REPORT & PERIOD COVERED: (9) FINAL Repts

6. PERFORMING ORG. REPORT NUMBER:

7. AUTHOR(s): (10) F. Keith Jolls, PE

8. CONTRACT OR GRANT NUMBER(s): (15) DACW61-78-C-0124

9. PERFORMING ORGANIZATION NAME AND ADDRESS:
Louis Berger & Assoc.
100 Halstead St.
East Orange, N.J. 07019

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS:

11. CONTROLLING OFFICE NAME AND ADDRESS:
U.S. Army Engineer District, Philadelphia
Custom House, 2d & Chestnut Streets
Philadelphia, Pennsylvania 19106

12. REPORT DATE: (11) April, 1979

13. NUMBER OF PAGES: 62

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): (12) 67 p.

15. SECURITY CLASS. (of this report): Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

(6) National Dam Safety Program. Beaver Dam (NJ00077), Delaware River Basin, Buckshutem Creek, Cumberland County, New Jersey. Phase I Inspection Report.

18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service, Springfield, Virginia, 22151.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dams
Spillways
Structural Analysis
Safety
Visual Inspection
National Dam Inspection Act Report
Beaver Dam, N.J.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO

NAPEN-D

410 891

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, NJ 08621

25 MAY 1979

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Beaver Dam in Cumberland County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Beaver Dam, initially listed as a high hazard potential structure but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in fair overall condition. However, the dam's spillway is considered inadequate since 30 percent of the Spillway Design Flood-SDF-would overtop the dam. (The SDF, in this instance, is one half of the Probable Maximum Flood.) To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980.

b. Within one year from the date of approval of this report, the following actions should be taken:

(1) Replace the deteriorated timber in the spillway.

(2) Remove trees along the upstream crest of the dam and rebuild

the crest shoulders.

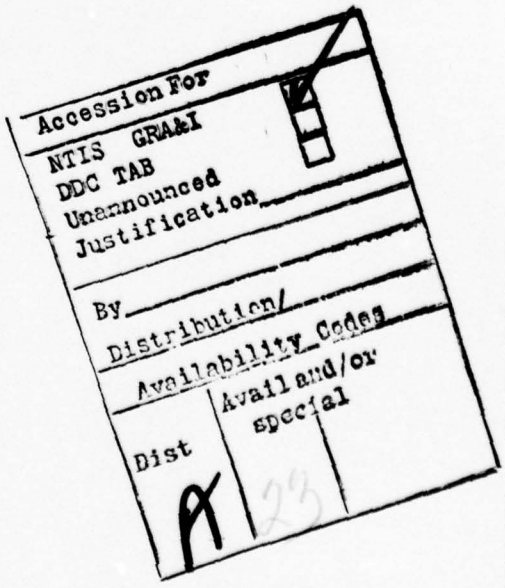
(3) Remove trash in the spillway and downstream embankments.

(4) The randomly dumped concrete building plank should be broken up into smaller segments and seated more uniformly into the backslopes. A gravel bedding layer should be placed under the concrete pieces.

c. A checklist of periodic maintenance inspections should be developed so records of conditions and repairs can be maintained.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman William J. Hughes of the Second District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.



NAPEN-D
Honorable Brendan T. Byrne

An important aspect of the Dam Safety Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

Copies furnished:
Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N. J. Dept. of Environmental Protection
P. O. Box CN029
Trenton, NJ 08625

John O'Dowd, Acting Chief
Bureau of Flood Plain Management
Division of Water Resources
N. J. Dept. of Environmental Protection
P. O. Box CN029
Trenton, NJ 08625

BEAVER DAM (NJ00077)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 10 January 1979 by Louis Berger and Associates, Inc. under contract to the State of New Jersey. The State, under agreement with the U. S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Beaver Dam, initially listed as a high hazard potential structure but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in fair overall condition. However, the dam's spillway is considered inadequate since 30 percent of the Spillway Design Flood-SDF-would overtop the dam. (The SDF, in this instance, is one half of the Probable Maximum Flood.) To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980.

b. Within one year from the date of approval of this report, the following actions should be taken:

(1) Replace the deteriorated timber in the spillway.

(2) Remove trees along the upstream crest of the dam and rebuild the crest shoulders.

(3) Remove trash in the spillway and downstream embankments.

(4) The randomly dumped concrete building plank should be broken up into smaller segments and seated more uniformly into the backslopes. A gravel bedding layer should be placed under the concrete pieces.

c. A checklist of periodic maintenance inspections should be developed so records of conditions and repairs can be maintained.

APPROVED: James G. Ton

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 29 May 1979

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam Beaver Dam Fed ID# NJ 00077 and NJ ID# 503

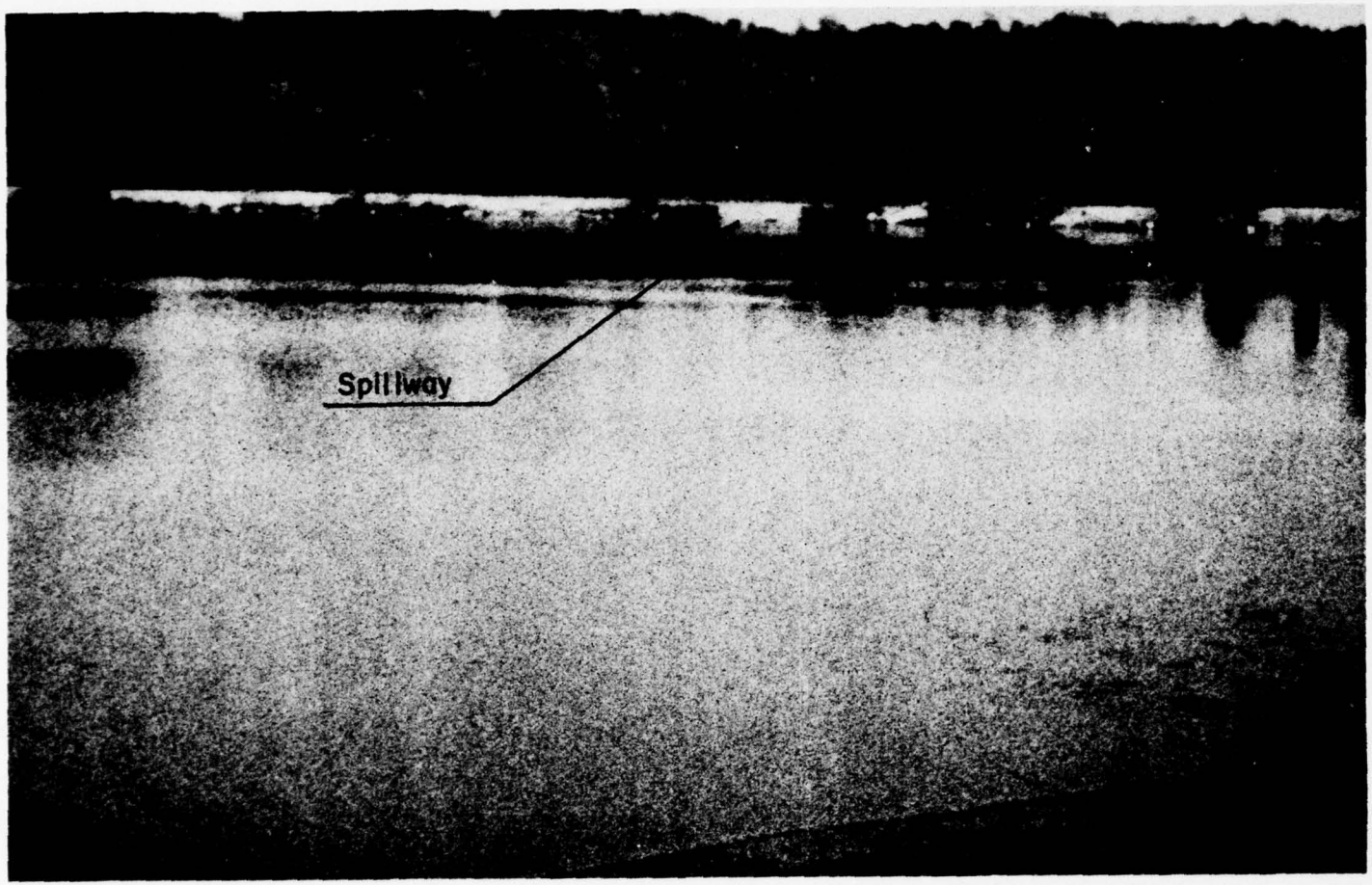
State Located New Jersey
County Located Cumberland
Coordinates Lat. 3920.2 - Long. 7502.5
Stream Buckshutem Creek
Date of Inspection 10 January 1979

ASSESSMENT OF GENERAL CONDITIONS

Beaver Dam is assessed to be a fair overall condition and is recommended to be downgraded from a high hazard to a significant hazard category. No detrimental findings were uncovered to render a hazardous assessment. Overtopping of the dam would not greatly increase the danger of loss of life or property damage as the discharge flows directly into the much larger Laurel Lake. Remedial actions recommended to be undertaken under a regular maintenance program in the near future are 1) replace the deteriorated timber in the spillway, 2) rebuild the crest shoulders and remove the trees, 3) remove the trash in the spillway and downstream embankments, and 4) breakup the concrete slope protection and properly rearrange pieces on the backslopes.

The dam has an inadequate spillway capacity, being able to accommodate only 29% of the design flood and it is recommended that further hydraulic/hydrologic studies be undertaken.

F. Keith Jolls P.E.
Project Manager



OVERVIEW OF BEAVER DAM

JANUARY 1979

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
NAME OF DAM: BEAVER DAM FED ID# NJ 00077

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority

This report is authorized by the Dam Inspection Act, Public Law 92-367, and has been prepared in accordance with Contract FPM-36 between Louis Berger & Associates, Inc. and the State of New Jersey and its Department of Environmental Protection, Division of Water Resources. The State, in turn, is under agreement with the U.S. Army Engineer District, Philadelphia, to have this inspection performed.

b. Purpose of Inspection

The purpose of this inspection is to evaluate the structural and hydraulic condition of the Beaver Dam and appurtenant structures, and to determine if the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances

Beaver Dam is a relatively old straight earth embankment approximately 700 feet long with a timber box spillway located about 200 feet from the south abutment. The three-sided spillway has a total overall crest length of 43 feet with one section of removeable flashboards 5 feet wide positioned in the center of the upstream face of the inlet. Discharge from the timber box exits downstream through two 66 inch round reinforced concrete pipes. This is the only hydraulic exit within the dam.

b. Location

Beaver Dam is located three-quarters of a mile southwest of the intersection of County Roads 670 (Buckshutem Road) and 627 (Mauricetown Road) in Laurel Lake, Commercial Township, Cumberland County and lies at the upper end of Laurel Lake, about 1.5 miles west of the Maurice River. The Millville Fish and Wildlife Management Area (a State Hunting and Fishing Grounds) is located just to the west of the lake.

c. Size Classification

The maximum hydraulic height of the dam is 10.8 feet and the maximum storage is estimated to be 295 acre-feet. Therefore, the dam is placed in the small size category as defined by the Recommended Guidelines for Safety Inspection of Dams (maximum storage less than 1,000 acre-feet and maximum height less than 25 feet).

d. Hazard Classification

Based on the Corps of Engineers criteria and the fact that in the event of a failure, appreciable damage could be inflicted on the Laurel Lake Dam (located 1.3 miles downstream) and possibly the bridge at Buckshutem Road, the classification is recommended to be downgraded to a significant hazard. Below Beaver Dam, the majority of the homes around Laurel Lake are situated above flood elevation and would probably not be flooded in the event of a failure. Further, the storage capacity of Beaver Lake is relatively small when compared to the size of Laurel Lake. In view of the foregoing, excessive economic loss is not foreseen; hence, the downgraded classification.

e. Ownership

According to Division of Water Resources records the dam is owned by the Laurel Lakes Development Corporation, 1 North 13th Street, Philadelphia, Pa. The inspection team contacted Mr. Harry Smith, Esq., Lake Shore

Drive, Laurel Lake, President of the Laurel Lakes Association who verified that his organization pays for and performs all maintenance.

f. Purpose of Dam

The dam impounds a recreation lake and was constructed by Laurel Lakes Development Corporation when this lake community was initially developed (see next paragraph).

g. Design and Construction History

The dam was reconstructed in 1957 by the Laurel Lake Development Corp. on the site of an older existing earth dam that had failed on November 14, 1927. The initial date of the first instance construction is unknown. This initial failure, which reportedly occured soon after the dam was built, was believed to be due to an inadequate spillway. A 75 foot gap was washed out in the vicinity of the spillway. Upon reconstruction in 1957, a timber core wall was built across the breached area but the existing sections of embankment were left intact. A new timber box drop inlet was constructed near the location of the earlier spillway and just to the right of the natural channel of Buckshutem Creek. About 6 years ago, the Lake Association added concrete riprap protection on both the upstream and downstream faces of the dam. Barriers have been installed at the abutments to forestall the use of the dam as a roadway. The dam is called Beaver Road Dam locally and at an earlier time, was addressed as the Beach Club Lake Dam.

h. Normal Operating Procedures

There are presently no specific operating procedures at this site except for the periodic maintenance of the spillway structure and embankment by members of the Laurel Lake Community Club. Club members also monitor the dam during periods of heavy flows. The extent and degree to which this takes place is unknown.

1.3 PERTINENT DATA

a. Drainage Area

The drainage area of Beaver Dam is 16.0 square miles.

b. Discharge of Dam Site

The spillway capacity with the reservoir level at the top of dam is calculated to be approximately 800 cfs. No discharge records are available at this site.

c. Elevation (Above M.S.L.)

Top of dam - +21±
Recreation Pool - +16.9 (Spillway crest)
Streambed at Center Line of Dam - +10.2

d. Reservoir

Length of Recreation Pool - 2000 feet
Length of Maximum Pool - 4700 feet

e. Storage

Top of dam - 295 acre-ft.
Recreation pool - 120 acre-ft.

f. Reservoir Surface

Top of dam - 50 acres
Recreation Pool - 30 acres

g. Dam

Type - Earth embankment with timber box spillway

Length - 700 feet

Structural height of spillway works - 25.0 feet

Hydraulic height - 10.8 feet

Freeboard between normal reservoir and top of dam - 4.1 feet

Top width - 10± feet

Side slopes - 3H:1V u/s; 2H:1V d/s

Zoning - composition and compactness unknown. Timber cut-off walls in portions of dam.

h. Diversion and Regulating Tunnel

None

i. Spillway

Type - 3-sided overflow timber box
Overall length of weir - 43 feet
Effective length - 40 feet
Crest elevation - +16.9 (flashboards in place)

j. Regulating Outlets

Removable flashboards in spillway section.
Minimum invert elevation - +10.7 (flashboards removed)

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

The only design information located for review were two sheets of the 1957 construction plans for the spillway (attached herein). The work was designed by Mr. John Reutter, N.J.P.E. #3671 and was filed with Dam Application No. 503, dated 27 February 1957. No design computations were available nor were the plans for an earlier dam application (No. 109) located.

2.2 CONSTRUCTION

No information was available.

2.3 OPERATION

Department of Environmental Protection records indicate that the 1957 construction replaced an earlier structure that was washed out. The present dam appears to have operated satisfactorily as designed and reconstructed.

2.4 EVALUATION

a. Availability

In view of the size and hazard classification it is felt that sufficient engineering data is available except for geotechnical data of the embankment.

b. Adequacy

A review of the original plans indicate that the spillway was conservatively designed and from the results of the field inspection, is built in accordance with the design plans. Hence, from a structural standpoint, the engineering data is believed to be adequate.

c. Validity

Based on field observations, the validity of the 1957 design is not challenged but further

investigations would be required to fully assess the permeability of the embankment zones in the areas which were not washed out in the 1927 breaching.

SECTION 3 - VISUAL INSPECTIONS

3.1 a. General

Visual inspections were conducted on January 2 and 11, 1979. The reservoir water level at the time of the latter inspection was about 4 inches above the top of the intake flashboards and was discharging freely although the pool was frozen over. An earlier, informal inspection was conducted in September before the lake was frozen.

b. Dam

The embankment portions were found to be substantially as designed and in a stable condition although the design crest width and side slopes are extremely ill-defined. The lake level appears to be fairly constant during extensive periods as the banks are well stabilized and show little evidence of sloughing at higher water levels. It appears that after the 1927 breaching the uncontrolled flow was allowed to revert into the natural riverbed of Buchshutem Creek (as evidenced by secondary growth in the upper end of the reservoir). The embankment backslopes are covered with secondary timber growth and there is quite an extensive amount of trash dumped on the downstream face to the right of the spillway. The dam crest is quite uneven and has sloughed off at the shoulder lines. Certain areas near the right abutment have distinct erosion swales established as have numerous other zones on both the upstream and downstream faces. Much of the crest erosion is caused by minibike rutting, especially at the left abutment where the effective crest width is presently only about 5 feet.

Although the difference in normal pool levels between Beaver and Laurel Lakes averages only about 6.5 feet, there is seepage evident along the downstream toes in several zones between 100 and 175 feet north of the spillway channel.

Moreover, a substantial portion of the downstream toe of slope of Beaver Dam is inundated by the Laurel Lake tailwater.

A considerable amount of broken concrete building floor planking has been dumped each side of the 66" RCP pipe outlets. However, it is poorly positioned and its effectiveness as slope protection is thought to be marginal since the planking may be masking eroded pockets or burrows beneath.

c. Appurtenant Structures

The timber box drop inlet and 66-inch reinforced concrete pipe outlets are in satisfactory condition. The exposed concrete headwall at the upstream shoulder line has no major structural cracking and the short 15 foot sections of timber bulkhead on each side of the intake are plumb but have suffered dry-rot in some of the upper planks. The 13 x 17 foot rectangular spillway is founded on eight 12" cedar piles and the outlet pipes are supported by the concrete headwall and cutoff walls. There is a considerable amount of timber debris collected in the box inlet but this can be easily removed. Additionally, there are 3" tongue and groove timber corewalls along the dam axis each side of the spillway and in the zone near the left abutment where the 1927 breaching occured (see Figure 2).

d. Reservoir

Beaver Lake is substantially clear of debris and has a fairly well defined shoreline composed of the silty and clayey sands which predominate in this area. However, this material is quite susceptible to erosion. Upstream from the lake lies Buckshutem Swamp which has an extensive latent storage capacity. The original subdivision development plans had envisioned a much larger lake (over 200 acres) than the presently impounded reservoir.

e. Downstream Channel

The outlet of the study dam discharges directly into the headwaters of Laurel Lake which is situated directly to the east. This lake is another but much larger community recreational facility and is maintained by an overflow structure just east of the county bridge on Buckshutem Road. This lower dam was rebuilt after having failed in the late 1950's. Immediately below this dam, Buckshutem Creek discharges directly into the tidal flats of the Maurice River.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

Operational procedures were not observed by the inspection team. Discussions were held with Mr. Harry Smith, President of the Lake Association and local residents regarding the operational history of the dam.

4.2 MAINTENANCE OF DAM

Maintenance is carried out as part of the dues-paying club membership program for their association's facilities. The dam is periodically inspected and repairs made on an as-needed basis.

4.3 MAINTENANCE OF OPERATING FACILITIES

There are no operating facilities except for the removable stoplogs in the upstream face of the box inlet. It appears these are normally not adjusted as the planking is wedged tightly in place.

4.4 DESCRIPTION OF WARNING SYSTEM IN EFFECT

There is no formalized warning system in effect as the dam has not been overtopped since the early 1927 collapse. Association personnel monitor the spillway during periods of heavy flow to keep it free from debris.

4.5 EVALUATION OF OPERATIONAL ADEQUACY

Present procedures and safeguards are deemed to be adequate in view of the performance record and the lack of hazards at this site. The Laurel Lake Association has an experienced cadre of residents who share a vital interest in the upkeep of their facilities.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data

Pursuant to the Recommended Guidelines for Safety Inspection of Dams, Beaver Dam is of small size and significant hazard. Accordingly a spillway design flood of one half the probable maximum flood (PMF) was selected by the inspection team to test the spillway capacity and overtopping potential. Precipitation data was obtained from Hydrometeorological Report No. 33. In accordance with Corps of Engineers directives, the inflow hydrograph and flood routing were obtained utilizing the HEC-1 computer program. Peak inflow to the reservoir for the ½ PMF was 2,760 cfs and remained approximately the same after the inflow was routed through the reservoir. The maximum spillway discharge capacity is calculated to be 800 cfs. Hence, the spillway can accommodate only 29% of the spillway design flood. This flood would cause the dam to be overtopped by approximately 1.1 feet.

b. Experience Data

The dam was originally designed to accommodate a 100-year frequency event of 475 cfs according to Dam Application records. There is no other information available as to the performance of this dam, as there are no streamflow records available.

c. Visual Observations

The dam inlet functions adequately although there was some debris in the inlet at the time of the inspection. Judging from its appearance, the dam's crest has not been overtopped since its 1957 reconstruction. As previously stated, the 1927 failure was attributed to an undersized spillway but no data was available as to its size or discharge capacity.

d. Overtopping Potential

Although the spillway can accommodate less than a third of the design flood, the overtopping potential is believed not to be of a highly critical concern in view of the lake's small storage capacity and low hydraulic head differential.

e. Drawdown Potential

The lake can only be drawn down 6.2 feet to elevation 10.7, (assuming the stop planks can be removed). Drawdown to this elevation would take approximately one day. There is no provision for any further drawdown.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations

Based on the visual inspection and the review of the spillway design, the Beaver Dam is evaluated as being in a fair overall structural condition. The inspection team was principally concerned with the gradual erosion of the crest embankment shoulders especially to the left of the spillway backslope and below the right abutment. The continual sloughing away of these slopes could eventually create a breaching hazard. Similarly, the trash dumped below the spillway could create a rodent-infestation problem with burrows and their attendant piping weaknesses in the embankment.

The spillway and outfall pipes are in satisfactory condition with minor structural deficiencies. However, the inlet requires periodic cleaning as debris tends to be contained at the pipe entrances.

b. Design & Construction Data

The spillway and outfall foundation supports were deemed to be conservatively designed although no actual computations were available. The hydraulic differential is such that no stress or stability problems are foreseen. There is some concern as to the interface between the 1957 corewall where it joins the earlier installed corewall but this can not be observed without digging test pits. With the modest differential hydraulic head, seepage through the embankment is not viewed as a potentially dangerous condition.

c. Operating Records

Although there are no operating records maintained, there has been little required upkeep of the dam structure.

d. Post Construction Changes

There have been no modifications to the hydraulic capabilities since the installation of the spillway. The broken chunks of concrete building plank that have been dumped on the slopes around the pipe sluiceways and the drop inlet are the only evidences of post-construction changes.

e. Seismic Stability

Beaver Dam is located in Zone 1 and experience indicates that dams will have adequate stability under dynamic loading conditions if stable under static loading conditions.

SECTION 7 - ASSESSMENTS/RECOMMENATIONS/ PROPOSED REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Subject to the inherent limitations of the Phase I visual inspection, Beaver Dam is classified as being in a fair overall condition although the spillway is incapable of passing the design flood. The embankment is built of unknown composition but due to its apparent impermeable composition, timber cut-off wall and lack of serious evidence of seepage, is felt to be of a sufficient impervious condition to withstand normal hydraulic heads. The present spillway capacity is inadequate and does not meet the requirements of the Recommended Guidelines for Safety Inspection of Dams, being able to accommodate only 29% of the spillway design flood as calculated by Corps of Engineers criteria. However, the SDF is calculated to overtop the dam by only slightly more than one foot and except for possible erosion damage to the backslopes, the overtopping danger is believed to be negligible.

b. Adequacy of Information

The information obtained for the Phase I inspection is deemed to be adequate and it is believed that little else is available. Performance data is also believed to be non-existent. However, in view of the hazard classification and downstream conditions, the information is considered satisfactory for the assessment contained herein.

c. Urgency

A collapse of Beaver Dam could endanger the lower dam of Laurel Lake but it is felt this event would be highly problematical. In view of all mitigating conditions, no urgency is attached to implementing further studies and it is recommended that the remedial measures

set forth below be taken under advisement in the near future and be undertaken by the owners as part of their regular maintenance program.

d. Necessity for Further Study

Due to the downgraded significant hazard classification recommended herein and the fact that little property damage is likely in the event of a collapse, further structural studies regarding the dam itself are believed to be unnecessary. However, additional hydraulic/hydrologic studies are recommended (in conjunction with the lower dam).

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

a. Recommendations

1) On the basis of the present conditions and geometry, remedial improvements to the existing spillway is not warranted. The deteriorated upper members of bulkhead and inlet should be replaced and the debris cleaned out of the inlet and pipes.

2) The shoulders of the crest should be regraded, levelled and compacted and the trees removed along the upstream crest.

3) The trash should be cleared from the backslope near the south abutment and the area regraded and seeded.

4) The randomly dumped concrete building plank could be broken up into smaller segments and seated more uniformly into the backslopes. A gravel bedding layer should be placed under the concrete pieces where complete relocation is feasible.

b. O&M Maintenance and Procedures

No additional procedures other than those presently in effect are warranted except it is recommended that a checklist of periodic maintenance inspections be developed so records of conditions and repairs can be maintained.

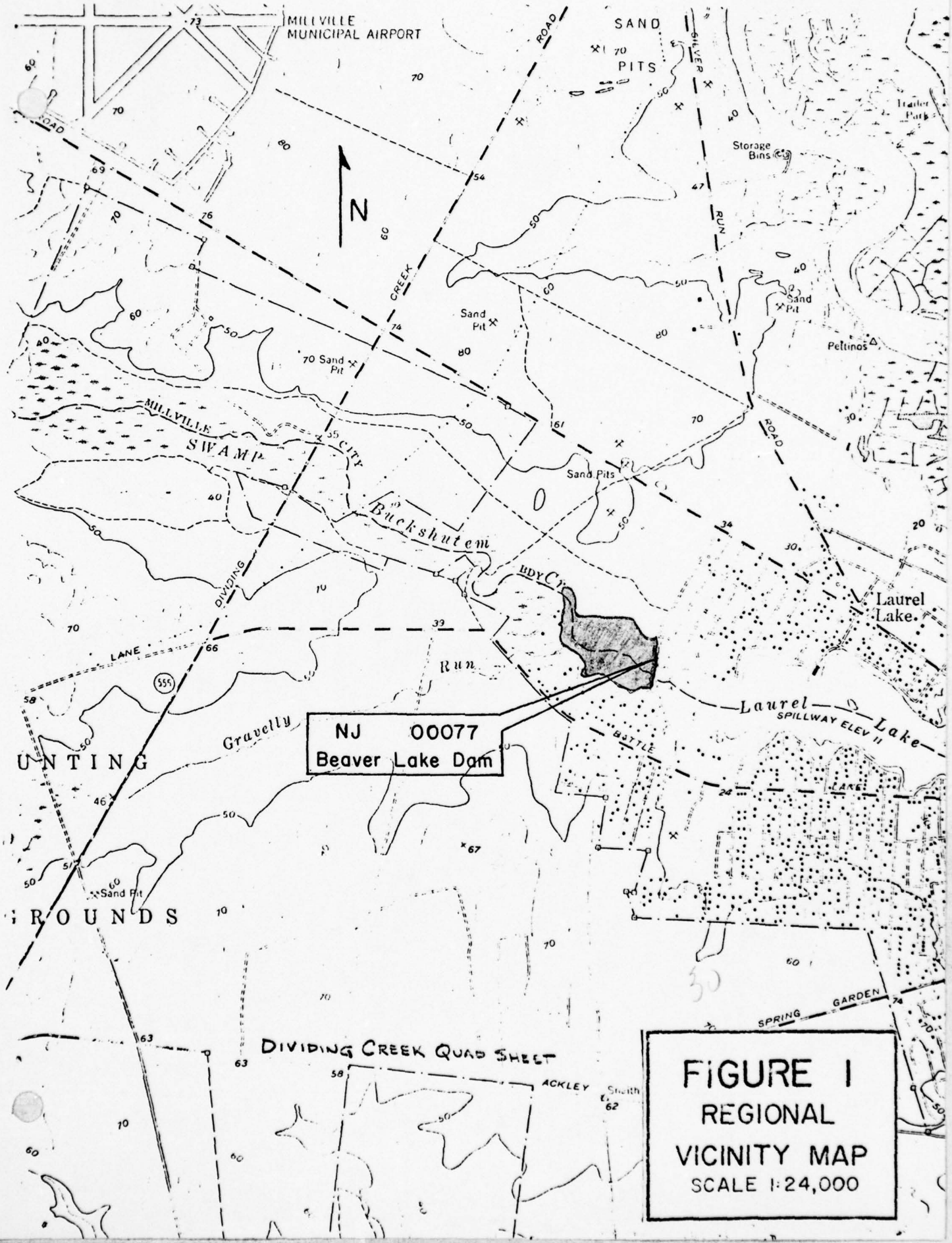


FIGURE 1
REGIONAL
VICINITY MAP
SCALE 1:24,000

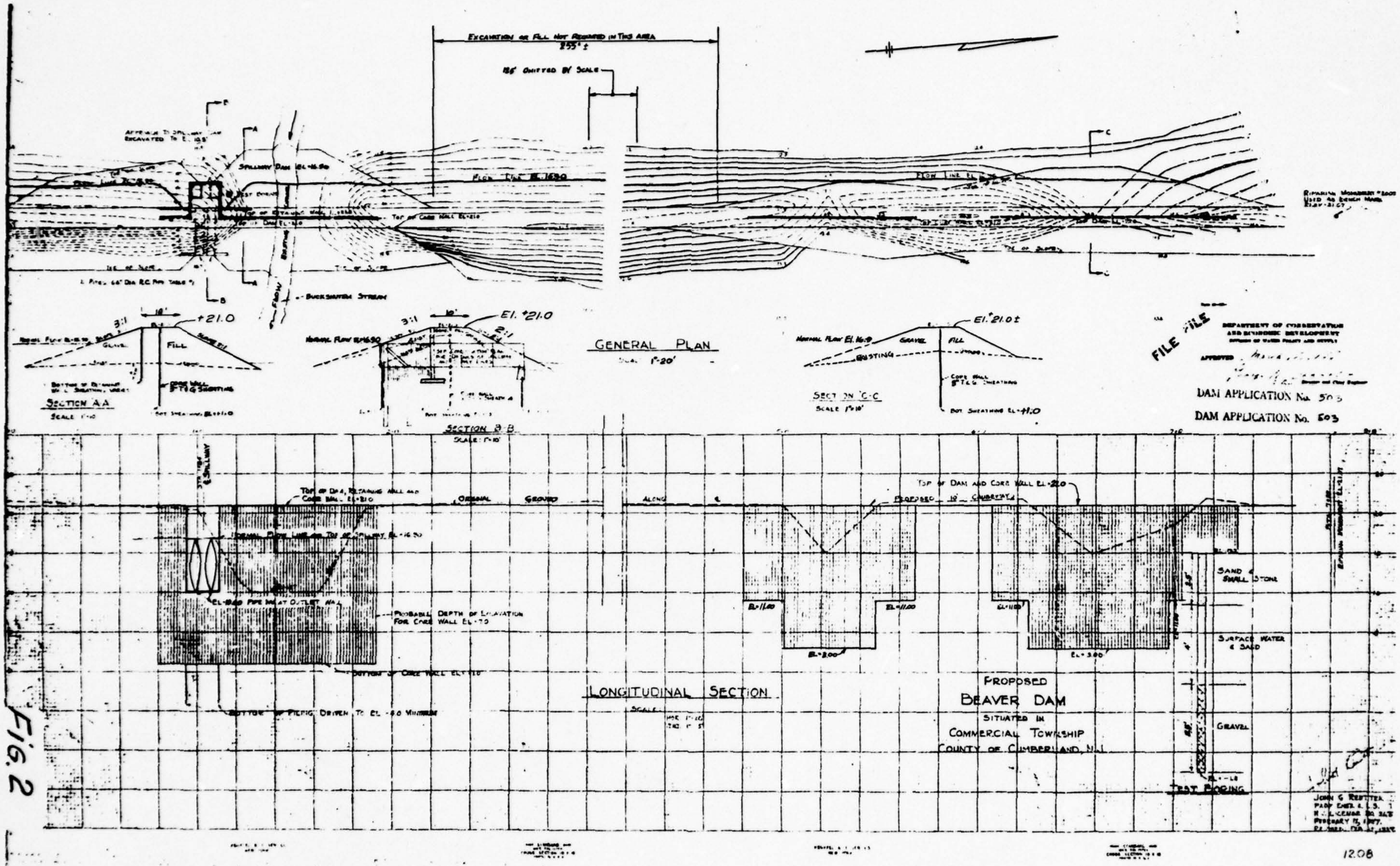
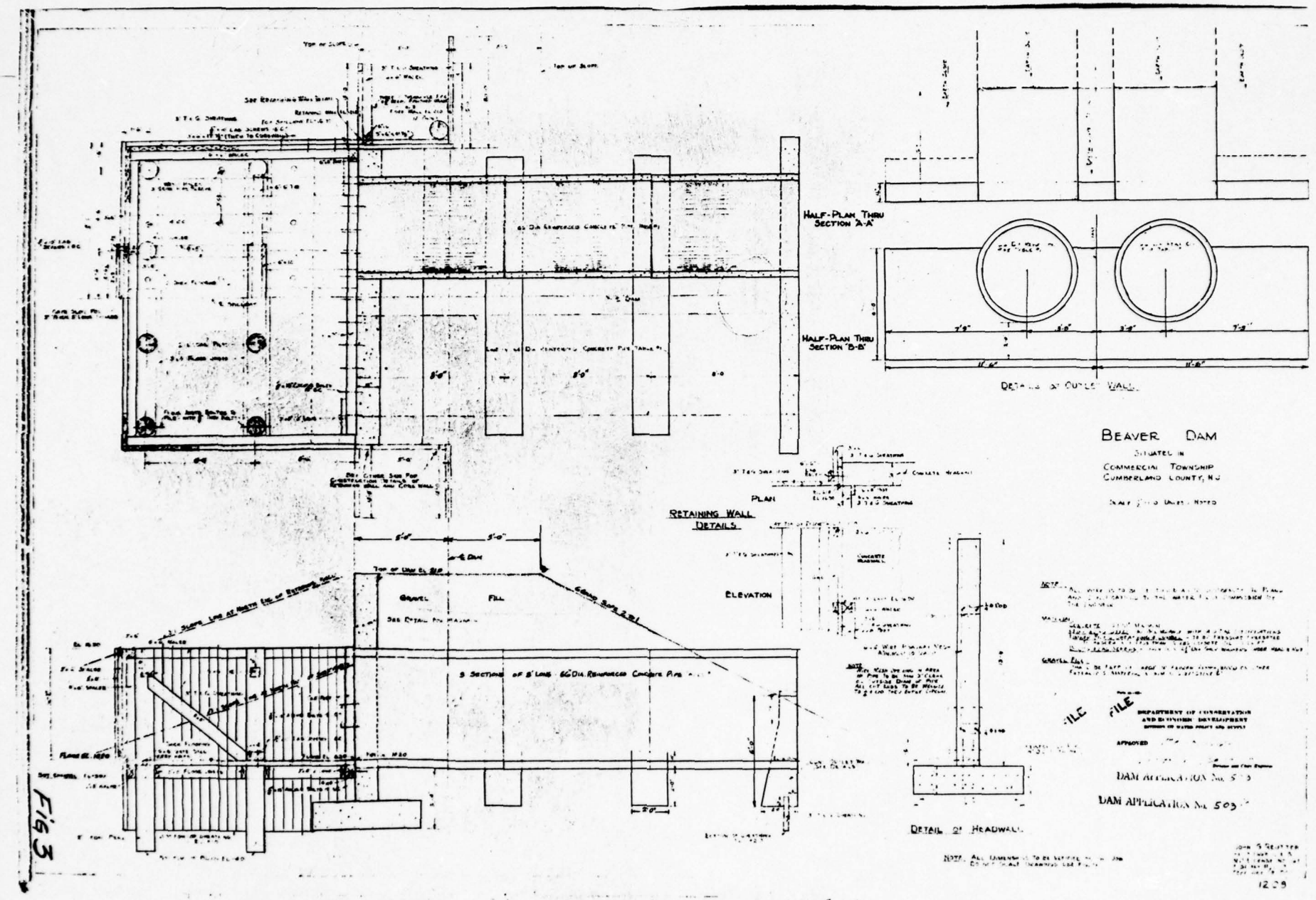

EXCAVATION OR FILL NOT REQUIRED IN THIS AREA
255'±
18' OMITTED BY SCALE
SPILLWAY DAM EL.+16.90
FLOW LINE EL.16.90
TOP OF CORE WALL EL.+21.0
FLOW
BUCKSHUTEM STREAM
FLOW LINE
GENERAL PLAN
SCALE 1"=20'
SECTION A-A
SCALE 1"=10'
SECTION B-B
SCALE 1"=10'
SECT. ON 'C-C'
SCALE 1"=10'
+21.0
El. +21.0
El. +21.0±
FILL
GRAVEL
EXISTING
CORE WALL
3:1
2:1
NORMAL FLOW EL.+16.90
NORMAL FLOW EL.16.9
BOT. SHEATHING EL.-11.0
FILE FILE
DEPARTMENT OF CONSERVATION AND ECONOMIC DEVELOPMENT
APPROVED
DAM APPLICATION No. 503
DAM APPLICATION No. 503
TOP OF DAM, RETAINING WALL AND CORE WALL EL.+21.0
ORIGINAL GROUND
ALONG ℄
TOP OF DAM AND CORE WALL EL.+21.0
PROPOSED 10' CULVERT
EL.-11.00
EL.-20.00
EL.-30.00
PROBABLE DEPTH OF EXCAVATION FOR CORE WALL EL.-7.0
BOTTOM OF CORE WALL EL.-11.0
BOTTOM OF PILING DRIVEN TO EL.-40 MINIMUM
LONGITUDINAL SECTION
SAND & SMALL STONE
SURFACE WATER & SAND
GRAVEL
TEST BORING
PROPOSED
BEAVER DAM
SITUATED IN
COMMERCIAL TOWNSHIP
COUNTY OF CUMBERLAND, N.J.
JOHN G. REUTTER
1208

FIG. 2


HALF-PLAN THRU SECTION 'A-A'
HALF-PLAN THRU SECTION 'B-B'
DETAILS OF OUTLET WALL
BEAVER DAM
SITUATED IN
COMMERCIAL TOWNSHIP
CUMBERLAND COUNTY, N.J.
PLAN
RETAINING WALL DETAILS
ELEVATION
GRAVEL
FILL
5 SECTIONS OF 8' LONG 66" DIA. REINFORCED CONCRETE PIPE
DETAIL OF HEADWALL
DEPARTMENT OF CONSERVATION AND ECONOMIC DEVELOPMENT
APPROVED
DAM APPLICATION No. 503
DAM APPLICATION No. 503
12-29
FILE
FILE
FIG 3

Check List
Visual Inspection
Phase 1

Name Dam Beaver County Cumberland State New Jersey Coordinators NJDEP

Date(s) Inspection 2,11,Jan.1979 Weather Cloudy Temperature 18°

Pool Elevation at Time of Inspection + 17.2 M.S.L. Tailwater at Time of Inspection + 11.5 M.S.L.

Inspection Personnel:

K. Jolls
L. Cranston
R. Lang
E. Simone

K. Jolls Recorder

Dam No. 00077

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SEE PAGE ON LEAKAGE		
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	N/A	Pipes buried through dam embankment.
DRAINS	None	
WATER PASSAGES	None	
FOUNDATION	Timber sheeting and piles in spillway.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBERSVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	N/A	Entire structural system exposed is timber except upstream concrete headwall.
STRUCTURAL CRACKING	N/A	
VERTICAL AND HORIZONTAL ALIGNMENT	Satisfactory but irregular.	Short concrete parapet wall at spillway headwall.
MONOLITH JOINTS	N/A	
NSTRUCTION JOINTS	N/A	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	Some observed running transversely down slopes.	Sand and gravel fill repairs (little clay binder).
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None	The downstream toe completely obscured by siltation and tail-water from Laurel Lake.
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Headwaters of Laurel Lake cover downstream toe of slope.	Downstream slope on left-garbage disposal area.
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	Quite uneven. Evidence of recent repairs.	Very poorly maintained.
RIPRAP FAILURES	Loose pieces of flexicore concrete plank forms protection around spillway and adjacent slopes.	Poorly placed. Affords very little protection. Requires seating and proper positioning.

EMBANKMENT

UAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
NCTION OF EMBANKMENT D ABUTMENT, SPILLWAY D DAM	Satisfactory	
NY NOTICEABLE SEEPAGE	Minor - to left of spillway (100 to 175')	Seepage observed only at toe of slope and not up within embankment area.
TAFF GAGE AND RECORDER	None	
AINS	None	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	No concrete except pipe headwalls (all underwater).	
INTAKE STRUCTURE	17 x 13 x 6' drop timber drop inlet with concrete headwall at dam crest. (16' long).	Vertical timber planking driven along concrete headwall each side.
OUTLET STRUCTURE	2-66" RCP.	Pipes in good alinement. Exhibit no settling.
OUTLET CHANNEL	Some scour just below outlet of pipes. Short channel length before discharging into Laurel Lake.	Ill-defined channel.
EMERGENCY GATE	None except removable stop logs in front of box inlet.	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	N/A	
APPROACH CHANNEL	N/A	
DISCHARGE CHANNEL	N/A	
BRIDGE AND PIERS	None	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	N/A	
APPROACH CHANNEL	N/A	
DISCHARGE CHANNEL	N/A	
BRIDGE AND PIERS	N/A	
GATES AND OPERATION EQUIPMENT	N/A	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None observed at dam axis.	Riparian Monument No. 2009 at left abutment. (Could not be located in field).
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER		

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Very flat. Many dead trees in water.	Numerous dead trees in pool in upstream end of lake.
SEDIMENTATION	Silted right up to spillway crest at dam.	Entire lake appears to be quite shallow.

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Much debris and sewage foam at outlet.	
SLOPES	Flat	
APPROXIMATE NO. OF HOMES AND POPULATION	None within potential flooding zones.	Homes along Laurel Lake sufficiently above flood elevations.

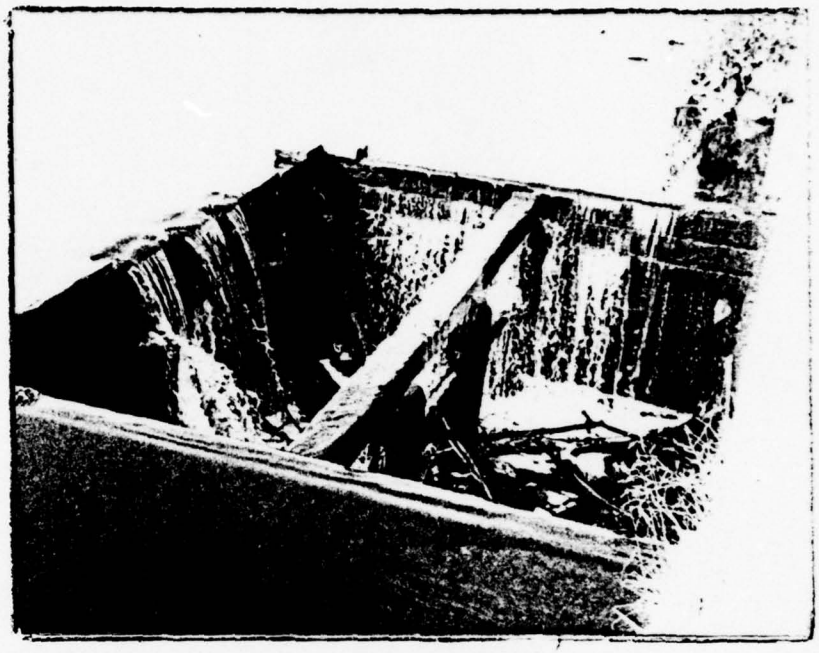
CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS	
PLAN OF DAM	Available *	* N.J.D.E.P.
REGIONAL VICINITY MAP	Available (Quad sheet)	
CONSTRUCTION HISTORY	Available *	
TYPICAL SECTIONS OF DAM	Available *	
HYDROLOGIC/HYDRAULIC DATA	Available *	
OUTLETS - PLAN	Available *	
- DETAILS		
-CONSTRAINTS -DISCHARGE RATINGS		
RAINFALL/RESERVOIR RECORDS	None	

ITEM	REMARKS
DESIGN REPORTS	Not available
GEOLOGY REPORTS	Not available
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Not available
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	Only 1 boring on plans.
POST-CONSTRUCTION SURVEYS OF DAM	N/A
BORROW SOURCES	N/A

ITEM	REMARKS
MONITORING SYSTEMS	None
MODIFICATIONS	None
HIGH POOL RECORDS	None
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	Available
MAINTENANCE OPERATION RECORDS	N/A

ITEM	REMARKS
SPILLWAY PLAN	Available*
SECTIONS	Available*
DETAILS	Available*
OPERATING EQUIPMENT PLANS & DETAILS	None



Timber box spillway

September 1978

Outfall of 2-66"Ø R.C.P.

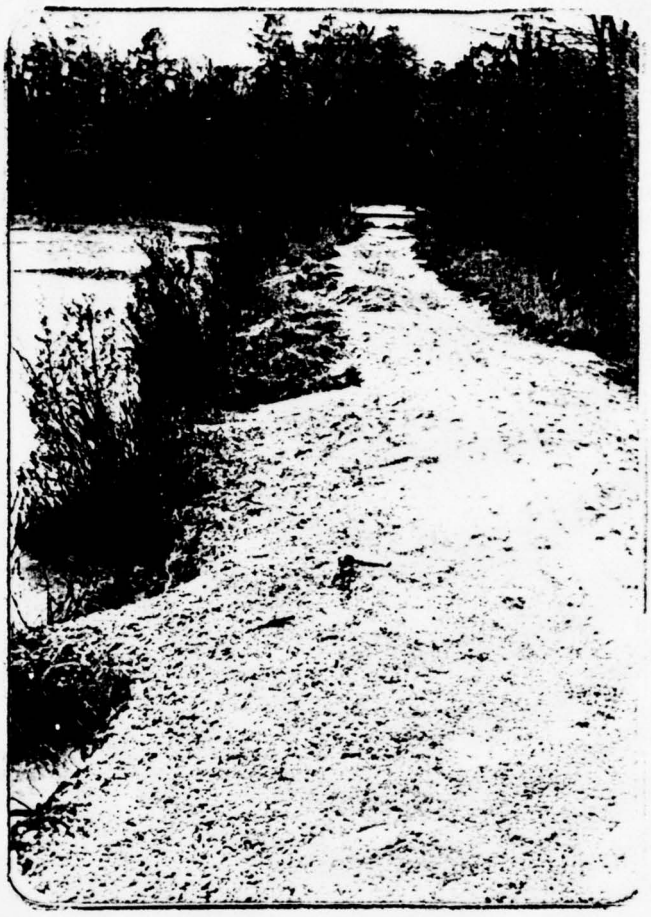
September 1978

View North along crest

September 1978

Downstream channel (Laurel Lake)

September 1978



Earth embankment left of spillway

January 1979

View South from left abutment

January 1979

Dam No. 00077

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 16.0 sq.mi. (flat N.J. sand schrub pinelands)

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): + 16.90 (120 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): + 21.0 (295 acre-feet)

ELEVATION MAXIMUM DESIGN POOL: + 19.5 (Application No. 503)

ELEVATION TOP DAM: + 21.0 M.S.L.

CREST:

a. Elevation + 19.5
b. Type 3 sided timber box drop inlet
c. Width 1.0'
d. Length 40'
e. Location Spillover None
f. Number and Type of Gates None

OUTLET WORKS:

a. Type 2-66" RCP
b. Location 200 ± feet from south abutment
c. Entrance inverts + 10.2
d. Exit inverts + 10.2
e. Emergency draindown facilities None except stoplog removal

HYDROMETEOROLOGICAL GAGES: Partial record station at Laurel Lake

a. Type -
b. Location Rt. 555 bridge at lower end of Laurel Lake.
c. Records 1976 only. 1.1 CFS maximum flow

MAXIMUM NON-DAMAGING DISCHARGE: 1100 CFS (928 CFS on Application No. 503)

BY [illegible] DATE [illegible]

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. A1 OF

CHKD. BY DATE

[illegible] Lake Dam Inspection

PROJECT [illegible]

SUBJECT

SNYDER COEFFICIENT (FROM CORPS OF ENGINEERS)

$C_p = 0.43$

Length of longest watercourse $L = 5.61$ miles

Length along watercourse to centroid $L_c = 3.03$ miles

$L \times L_c = 17.0$

Using plate 17, curve #2 Special project memo No. 459

$t_p = 18$ hours

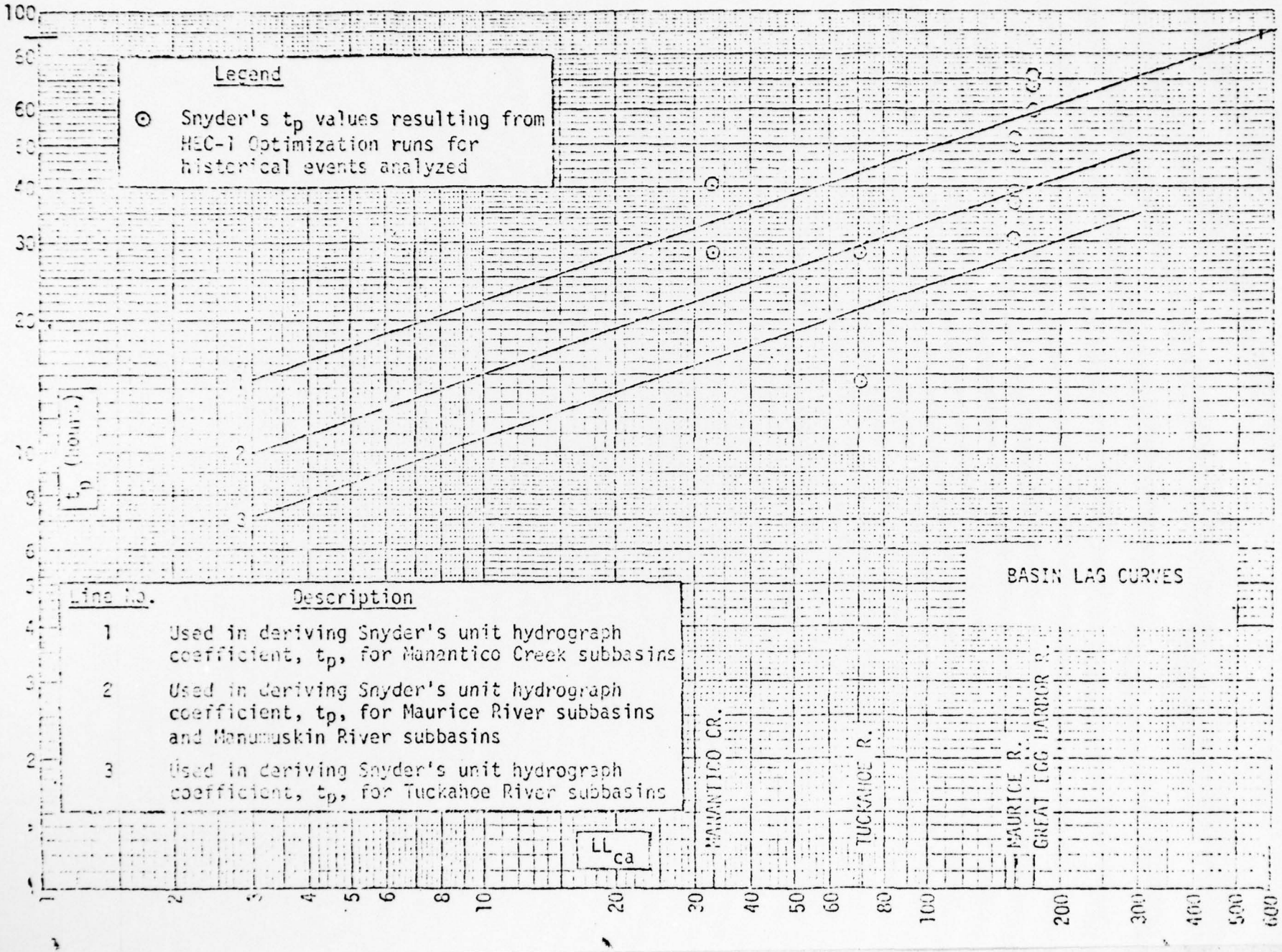
<u>Precipitation</u>

PMF for 200 sq. mi. area 24 hrs duration = 24"

Maximum 6-hour percentage = 110

Maximum 12-hour percentage = 119

Maximum 24-hour percentage = 128


Legend
⊙ Snyder's t_p values resulting from HEC-1 Optimization runs for historical events analyzed
t_p (hours)
LL_{ca}
Line No. Description
1 Used in deriving Snyder's unit hydrograph coefficient, t_p, for Manantico Creek subbasins
2 Used in deriving Snyder's unit hydrograph coefficient, t_p, for Maurice River subbasins and Manumuskin River subbasins
3 Used in deriving Snyder's unit hydrograph coefficient, t_p, for Tuckahoe River subbasins
MANANTICO CR.
TUCKAHOE R.
MAURICE R.
GREAT EGG HARBOR R.
BASIN LAG CURVES

BY. D.J.M. DATE 3-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 43 OF...

CHKD. BY..... DATE..... BEAVER LAKE DAM INSPECTION PROJECT.....

SUBJECT..... Spillway discharge calculations.....

Effective length of crest = 40' invert of pipes = 1110 (@ outlet)

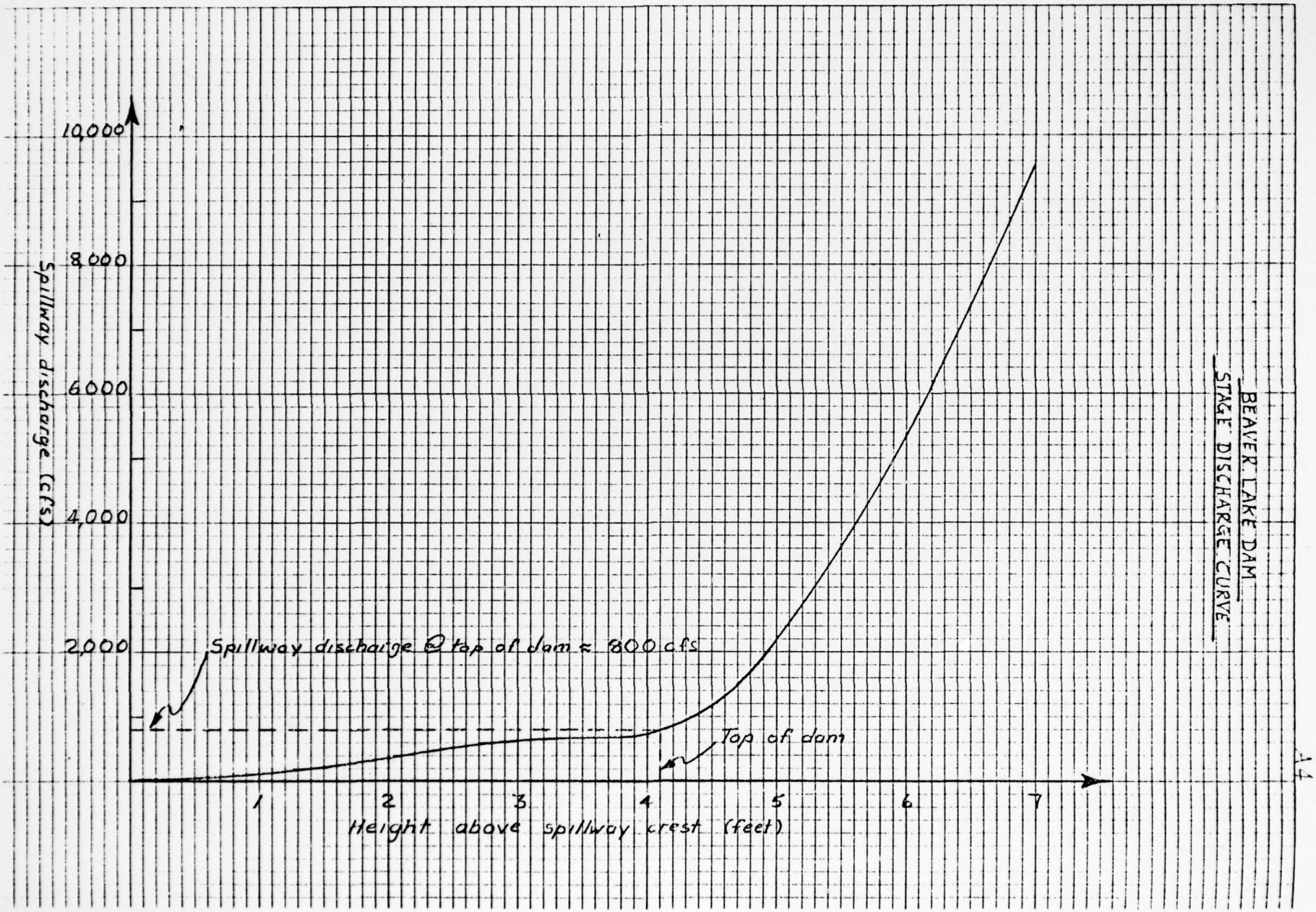
Over Crest			Thru 2 66" pipes		Controlling discharge
H	C	Q	H	Q	Q
1	3.1	124	7.9	589	124
2	3.1	351	8.9	625	351
3	3.1	644	9.9	659	644
4	3.1	992	10.9	692	692
5	3.1	1386	11.9	723	723
5.5	3.1	1599	12.4	738	738
6	3.1	1822	12.9	753	753
6.5	3.1	2055	13.4	767	767
7	3.1	2297	13.9	781	781

Over dam L=680'

H	C	Q
0.9	2.6	1,510
1.4	2.6	2,929
1.9	2.6	4,630
2.4	2.6	6,574
2.9	2.6	8,731

ΣQ

H	Q
1	124
2	351
3	644
4	692
5	2,233
5.5	3,667
6.0	5,383
6.5	7,341
7.0	9,512

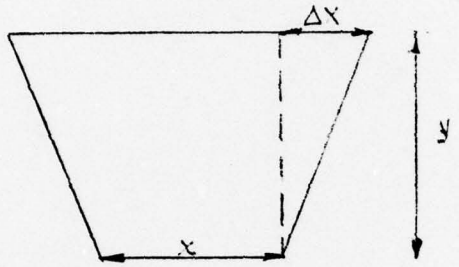


BY D.L. DATE Jan '71 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A5 OF...

CHKD. BY..... DATE..... BEAVER LAKE DAM TOMKINSVILLE PROJECT E-226

SUBJECT STAGE - STORAGE CALCULATION

Area of lake at elev 16.90 = 30 acres
Area of contour at elev. 20.0 = 49.4 acres



Increment in volume = $\Delta V \approx (x + \Delta x)\, y$

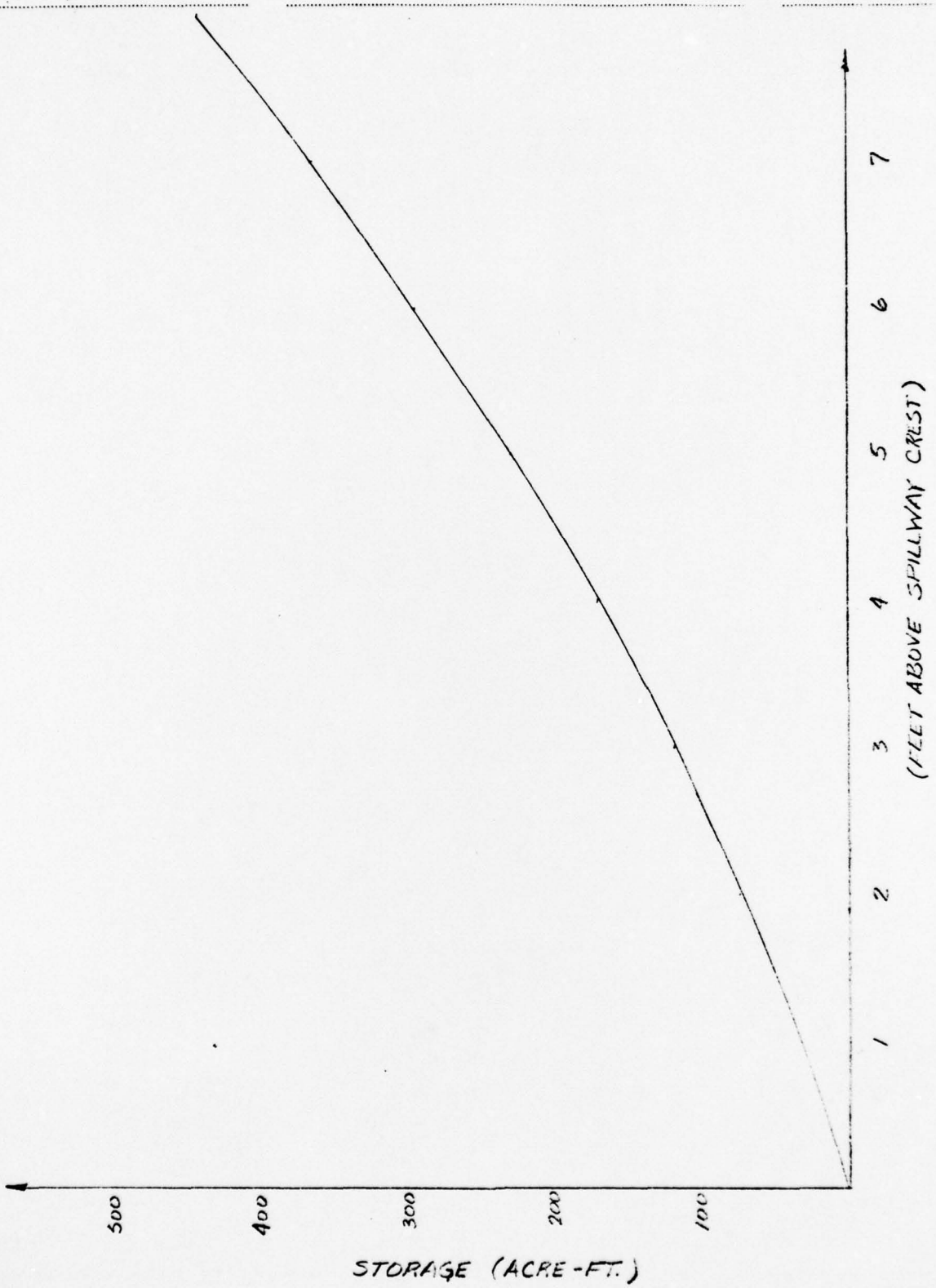
Height above crest (ft)	Storage (acre-ft.)
1	33
2	73
3	118
4	170
5	228
6	293
7	363
8	440
9	522
10	613

BY D.L. DATE Jan '79 SUBJECT SEAVER DAM

CHKD. BY DATE STAGE - STORAGE

SHEET NO. A6 OF

JOB NO. C-226



BY D.L. DATE Jan '71 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 17 OF
CHKD. BY DATE FLANDERS LAKE DAM INVESTIGATION PROJECT S-226
SUBJECT DRAWDOWN CAPACITY

Drawdown possible with stoplogs removed
Minimum invert elevation = 10.7'
Effective width = 5.0'
Volume of lake = $30 \times 43560 \times 4.0$
= 5,227,200 ft³

Assume drawdown under average head of 3.10'
C = 3.10

Discharge = $3.10 \times 5.0 \times (3.10)^{1.5}$

= 85 cfs

Time required to drawdown lake to El. +10.70

$$= \frac{5,227,200}{85 \times 3600}$$

= 17.1 hours ≈ 0.70 days say one day.

BEAVER LAKE DAM INSPECTION SOUTH GROUP C226
BY R.G.LANG
JANUARY 1979

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
150	2	0	0	0	0	0	0	0	0

JOPER 5 NWT 0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 5 LRTIO= 1
RTIOS= 1.00 0.50 0.40 0.20 0.10

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
3	0	0	0	0	0	1

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	16.00	0.0	16.00	0.0	0.0	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.0	24.00	110.00	119.00	128.00	0.0	0.0	0.0

TRSPC COMPUTED BY THE PROGRAM IS 0.816

LOSS DATA

STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0.0	0.0	1.00	0.0	0.0	1.00	0.50	0.10	0.0	0.0

UNIT HYDROGRAPH DATA
TP= 18.00 CP=0.43 NTA= 0

RECESSION DATA
STRTQ= 0.0 QRCSN= 0.0 RTIOR= 1.00
APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 9.38 AND R=15.27 INTERVALS

UNIT HYDROGRAPH 86 END-OF-PERIOD ORDINATES, LAG= 18.10 HOURS, CP= 0.43 VOL= 1.00

8.	30.	62.	100.	142.	182.	214.	238.	250.	248.
234.	219.	205.	192.	180.	168.	158.	148.	138.	130.
121.	114.	106.	100.	93.	87.	82.	77.	72.	67.
63.	59.	55.	52.	49.	45.	43.	40.	37.	35.
33.	31.	29.	27.	25.	24.	22.	21.	19.	18.
17.	16.	15.	14.	13.	12.	11.	11.	10.	9.
9.	8.	8.	7.	7.	6.	6.	6.	5.	5.
5.	4.	4.	4.	4.	3.	3.	3.	3.	3.
2.	2.	2.	2.	2.	2.				

BY D J M DATE 4-79
CHKD. BY _____ DATE _____
SUBJECT _____
LOUIS BERGER & ASSOCIATES INC.
PROJECT _____
SHEET NO. A2 OF _____

BY. D J M DATE 4-79

CHKD. BY_____DATE_____

SUBJECT_____

LOUIS BERGER & ASSOCIATES INC.

BEAVER LAKE DAM

SHEET NO. A9 OF...

PROJECT_____

TIME	END-OF-PERIOD FLOW RAIN	EXCS	COMP Q
1	0.23	0.00	0.
2	0.23	0.00	0.
3	0.23	0.03	0.
4	0.59	0.39	4.
5	0.59	0.39	17.
6	0.59	0.39	42.
7	5.60	5.40	122.
8	11.42	11.22	377.
9	4.52	4.32	882.
10	0.35	0.15	1586.
11	0.35	0.15	2414.
12	0.35	0.15	3296.
13	0.0	0.0	4130.
14	0.0	0.0	4812.
15	0.0	0.0	5290.
16	0.0	0.0	5517.
17	0.0	0.0	5463.
18	0.0	0.0	5211.
19	0.0	0.0	4900.
20	0.0	0.0	4596.
21	0.0	0.0	4307.
22	0.0	0.0	4034.
23	0.0	0.0	3778.
24	0.0	0.0	3539.
25	0.0	0.0	3314.
26	0.0	0.0	3104.
27	0.0	0.0	2907.
28	0.0	0.0	2723.
29	0.0	0.0	2550.
30	0.0	0.0	2388.
31	0.0	0.0	2237.
32	0.0	0.0	2095.
33	0.0	0.0	1962.
34	0.0	0.0	1838.
35	0.0	0.0	1721.
36	0.0	0.0	1612.
37	0.0	0.0	1510.
38	0.0	0.0	1414.
39	0.0	0.0	1324.
40	0.0	0.0	1240.
41	0.0	0.0	1162.
42	0.0	0.0	1088.
43	0.0	0.0	1019.
44	0.0	0.0	954.
45	0.0	0.0	894.
46	0.0	0.0	837.
47	0.0	0.0	784.
48	0.0	0.0	734.
49	0.0	0.0	688.
50	0.0	0.0	644.
51	0.0	0.0	603.
52	0.0	0.0	565.
53	0.0	0.0	529.
54	0.0	0.0	496.
55	0.0	0.0	464.
56	0.0	0.0	435.
57	0.0	0.0	407.
58	0.0	0.0	381.

59	0.0	0.0	357.
60	0.0	0.0	334.
61	0.0	0.0	313.
62	0.0	0.0	293.
63	0.0	0.0	275.
64	0.0	0.0	257.
65	0.0	0.0	241.
66	0.0	0.0	226.
67	0.0	0.0	211.
68	0.0	0.0	198.
69	0.0	0.0	185.
70	0.0	0.0	174.
71	0.0	0.0	163.
72	0.0	0.0	152.
73	0.0	0.0	143.
74	0.0	0.0	134.
75	0.0	0.0	125.
76	0.0	0.0	117.
77	0.0	0.0	110.
78	0.0	0.0	103.
79	0.0	0.0	96.
80	0.0	0.0	90.
81	0.0	0.0	84.
82	0.0	0.0	79.
83	0.0	0.0	74.
84	0.0	0.0	69.
85	0.0	0.0	65.
86	0.0	0.0	61.
87	0.0	0.0	57.
88	0.0	0.0	53.
89	0.0	0.0	50.
90	0.0	0.0	46.
91	0.0	0.0	43.
92	0.0	0.0	39.
93	0.0	0.0	28.
94	0.0	0.0	8.
95	0.0	0.0	1.
96	0.0	0.0	1.
97	0.0	0.0	0.
98	0.0	0.0	0.
99	0.0	0.0	0.
100	0.0	0.0	0.
101	0.0	0.0	0.
102	0.0	0.0	0.
103	0.0	0.0	0.
104	0.0	0.0	0.
105	0.0	0.0	0.
106	0.0	0.0	0.
107	0.0	0.0	0.
108	0.0	0.0	0.
109	0.0	0.0	0.
110	0.0	0.0	0.
111	0.0	0.0	0.
112	0.0	0.0	0.
113	0.0	0.0	0.
114	0.0	0.0	0.
115	0.0	0.0	0.
116	0.0	0.0	0.
117	0.0	0.0	0.
118	0.0	0.0	0.
119	0.0	0.0	0.

120	0.0	0.0	0.
121	0.0	0.0	0.
122	0.0	0.0	0.
123	0.0	0.0	0.
124	0.0	0.0	0.
125	0.0	0.0	0.
126	0.0	0.0	0.
127	0.0	0.0	0.
128	0.0	0.0	0.
129	0.0	0.0	0.
130	0.0	0.0	0.
131	0.0	0.0	0.
132	0.0	0.0	0.
133	0.0	0.0	0.
134	0.0	0.0	0.
135	0.0	0.0	0.
136	0.0	0.0	0.
137	0.0	0.0	0.
138	0.0	0.0	0.
139	0.0	0.0	0.
140	0.0	0.0	0.
141	0.0	0.0	0.
142	0.0	0.0	0.
143	0.0	0.0	0.
144	0.0	0.0	0.
145	0.0	0.0	0.
146	0.0	0.0	0.
147	0.0	0.0	0.
148	0.0	0.0	0.
149	0.0	0.0	0.
150	0.0	0.0	0.
SUM	25.05	22.59	115995.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5517.	5424.	4631.	2831.	115997.
INCHES		3.15	10.77	19.75	22.48
AC-FT		2691.	9191.	16856.	19183.

HYDROGRAPH AT STA 3 FOR PLAN 1, RTIO 1

0.	0.	0.	4.	17.	42.	122.	377.	882.	1586.
2414.	3296.	4130.	4812.	5290.	5517.	5463.	5211.	4900.	4596.
4307.	4034.	3778.	3539.	3314.	3104.	2907.	2723.	2550.	2388.
2237.	2095.	1962.	1838.	1721.	1612.	1510.	1414.	1324.	1240.
1162.	1088.	1019.	954.	894.	837.	784.	734.	688.	644.
603.	565.	529.	496.	464.	435.	407.	381.	357.	334.
313.	293.	275.	257.	241.	226.	211.	198.	185.	174.
163.	152.	143.	134.	125.	117.	110.	103.	96.	90.
84.	79.	74.	69.	65.	61.	57.	53.	50.	46.
43.	39.	28.	8.	1.	1.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5517.	5424.	4631.	2831.	115997.
INCHES		3.15	10.77	19.75	22.48
AC-FT		2691.	9191.	16856.	19183.

HYDROGRAPH AT STA 3 FOR PLAN 1, RTIO 2

0.	0.	0.	2.	8.	21.	61.	189.	441.	793.
1207.	1648.	2065.	2406.	2645.	2759.	2732.	2605.	2450.	2298.
2153.	2017.	1889.	1769.	1657.	1552.	1454.	1361.	1275.	1194.
1118.	1047.	981.	919.	861.	806.	755.	707.	662.	620.
581.	544.	509.	477.	447.	419.	392.	367.	344.	322.
302.	282.	265.	248.	232.	217.	204.	191.	179.	167.
157.	147.	137.	129.	121.	113.	106.	99.	93.	87.
81.	76.	71.	67.	63.	59.	55.	51.	48.	45.
42.	40.	37.	35.	33.	30.	29.	27.	25.	23.
21.	20.	14.	4.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2759.	2712.	2316.	1416.	58000.
INCHES		1.58	5.39	9.88	11.24
AC-FT		1345.	4596.	8428.	9592.

HYDROGRAPH AT STA 3 FOR PLAN 1, RTIO 3

0.	0.	0.	2.	7.	17.	49.	151.	353.	634.
965.	1319.	1652.	1925.	2116.	2207.	2185.	2084.	1960.	1838.
1723.	1614.	1511.	1415.	1326.	1242.	1163.	1089.	1020.	955.
895.	838.	785.	735.	688.	645.	604.	566.	530.	496.
465.	435.	408.	382.	358.	335.	314.	294.	275.	258.
241.	226.	212.	198.	186.	174.	163.	153.	143.	134.
125.	117.	110.	103.	96.	90.	85.	79.	74.	69.
65.	61.	57.	53.	50.	47.	44.	41.	39.	36.
34.	32.	30.	28.	26.	24.	23.	21.	20.	18.
17.	16.	11.	3.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2207.	2169.	1853.	1133.	46400.
INCHES		1.26	4.31	7.90	8.99
AC-FT		1076.	3676.	6743.	7673.

HYDROGRAPH AT STA 3 FOR PLAN 1, RTIO 4

0.	0.	0.	1.	3.	8.	24.	75.	176.	317.
483.	659.	826.	962.	1058.	1103.	1093.	1042.	980.	919.
861.	807.	756.	708.	663.	621.	581.	545.	510.	478.
447.	419.	392.	368.	344.	322.	302.	283.	265.	248.
232.	218.	204.	191.	179.	167.	157.	147.	138.	129.
121.	113.	106.	99.	93.	87.	81.	76.	71.	67.
63.	59.	55.	51.	48.	45.	42.	40.	37.	35.
33.	30.	29.	27.	25.	23.	22.	21.	19.	18.
17.	16.	15.	14.	13.	12.	11.	11.	10.	9.
9.	8.	6.	2.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1103.	1085.	926.	566.	23200.
INCHES		0.63	2.15	3.95	4.50
AC-FT		538.	1838.	3371.	3837.

HYDROGRAPH AT STA 3 FOR PLAN 1, RTIO 5

0.	0.	0.	0.	2.	4.	12.	38.	88.	159.
241.	330.	413.	481.	529.	552.	546.	521.	490.	460.
431.	403.	378.	354.	331.	310.	291.	272.	255.	239.
224.	209.	196.	184.	172.	161.	151.	141.	132.	124.
116.	109.	102.	95.	89.	84.	78.	73.	69.	64.
60.	56.	53.	50.	46.	43.	41.	38.	36.	33.
31.	29.	27.	26.	24.	23.	21.	20.	19.	17.
16.	15.	14.	13.	13.	12.	11.	10.	10.	9.
8.	8.	7.	7.	7.	6.	6.	5.	5.	5.
4.	4.	3.	1.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	552.	542.	463.	283.	11600.
INCHES		0.32	1.08	1.98	2.25
AC-FT		269.	919.	1686.	1918.

HYDROGRAPH ROUTING

ROUTING THROUGH RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
33	1	0	0	0	0	1

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.0	0.0	1	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
1	0	0	0.0	0.0	0.0	0.

STORAGE=	0.	33.	73.	118.	170.	226.	261.	293.	328.	363.
OUTFLOW=	0.	124.	351.	644.	692.	2233.	3667.	5383.	7341.	9512.

STATION 33, PLAN 1, RTIO 1

0.	0.	0.	1.	5.	17.	48.	150.	466.	935.
2434.	3084.	4078.	4720.	5260.	5495.	5487.	5241.	4938.	4628.
4340.	4063.	3807.	3570.	3348.	3133.	2936.	2749.	2575.	2412.
2259.	2127.	1990.	1865.	1746.	1636.	1532.	1435.	1344.	1258.
1179.	1104.	1034.	968.	907.	849.	795.	745.	698.	688.
679.	665.	649.	572.	507.	467.	435.	406.	380.	356.
335.	315.	295.	277.	259.	243.	227.	213.	199.	187.
175.	164.	153.	144.	135.	126.	120.	113.	107.	100.
94.	88.	83.	78.	73.	68.	64.	60.	56.	52.
49.	45.	40.	29.	18.	10.	5.	3.	1.	1.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

STOR

0.	0.	0.	0.	1.	4.	13.	38.	91.	179.
231.	247.	269.	281.	291.	295.	295.	290.	285.	279.
274.	268.	264.	259.	253.	248.	243.	239.	234.	230.
227.	222.	217.	213.	208.	204.	201.	197.	194.	191.
188.	185.	182.	180.	178.	176.	174.	172.	170.	166.
156.	141.	123.	107.	97.	91.	86.	82.	78.	74.
70.	67.	63.	60.	57.	54.	51.	49.	46.	44.
42.	40.	38.	36.	35.	33.	32.	30.	28.	27.
25.	24.	22.	21.	19.	18.	17.	16.	15.	14.
13.	12.	11.	8.	5.	3.	1.	1.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5495.	5414.	4636.	2823.	115997.
INCHES		3.15	10.78	19.69	22.48
AC-FT		2686.	9199.	16805.	19183.

STATION 33, PLAN 1, RTIO 2

0.	0.	0.	1.	3.	8.	24.	72.	209.	481.
685.	1651.	1937.	2365.	2613.	2750.	2742.	2628.	2473.	2320.
2180.	2048.	1916.	1795.	1681.	1575.	1475.	1381.	1294.	1212.
1135.	1063.	995.	932.	873.	818.	766.	717.	690.	683.
671.	656.	612.	529.	482.	448.	418.	391.	366.	344.
323.	303.	284.	266.	249.	234.	219.	205.	192.	180.
168.	158.	148.	138.	130.	122.	116.	110.	103.	97.
91.	85.	80.	75.	70.	66.	61.	57.	54.	50.
47.	44.	41.	39.	36.	34.	32.	30.	28.	26.
24.	22.	20.	15.	9.	5.	3.	1.	1.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

STOR

0.	0.	0.	0.	1.	2.	6.	19.	48.	93.
162.	205.	215.	229.	235.	239.	238.	236.	232.	228.
224.	219.	214.	210.	206.	202.	198.	195.	192.	189.
186.	183.	181.	179.	177.	175.	173.	171.	168.	160.
148.	131.	113.	100.	93.	88.	83.	79.	75.	72.
68.	65.	61.	58.	55.	52.	50.	47.	45.	43.
41.	39.	37.	36.	34.	32.	31.	29.	27.	26.
24.	23.	21.	20.	19.	17.	16.	15.	14.	13.
13.	12.	11.	10.	10.	9.	8.	8.	7.	7.
6.	6.	5.	4.	2.	1.	1.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2750.	2707.	2314.	1412.	58000.
INCHES		1.57	5.38	9.85	11.24

BY DJH DATE 4-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A15 OF...

CHKD. BY..... DATE..... BEAVER LAKE DAM PROJECT.....

SUBJECT.....

AC-FT 1343. 4592. 8405. 9592.

STATION 33, PLAN 1, RTIO 3

0.	0.	0.	0.	2.	7.	19.	57.	158.	374.
650.	961.	1689.	1827.	2096.	2187.	2200.	2110.	1988.	1865.
1748.	1637.	1533.	1436.	1345.	1260.	1180.	1105.	1035.	969.
908.	850.	796.	746.	698.	688.	679.	666.	649.	573.
508.	467.	435.	407.	381.	357.	335.	315.	296.	277.
259.	243.	228.	213.	200.	187.	175.	164.	154.	144.
135.	126.	120.	113.	107.	100.	94.	88.	83.	78.
73.	68.	64.	60.	56.	52.	49.	46.	43.	40.
38.	35.	33.	31.	29.	27.	25.	24.	22.	21.
19.	18.	16.	12.	7.	4.	2.	1.	1.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

STOR

0.	0.	0.	0.	1.	2.	5.	15.	39.	77.
124.	180.	206.	211.	221.	224.	225.	222.	217.	213.
208.	204.	201.	197.	194.	191.	188.	185.	182.	180.
178.	176.	174.	172.	170.	166.	156.	142.	123.	107.
97.	91.	86.	82.	78.	74.	70.	67.	63.	60.
57.	54.	51.	49.	46.	44.	42.	40.	38.	36.
35.	33.	32.	30.	28.	27.	25.	24.	22.	21.
19.	18.	17.	16.	15.	14.	13.	12.	11.	11.
10.	9.	9.	8.	8.	7.	7.	6.	6.	6.
5.	5.	4.	3.	2.	1.	1.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2200.	2165.	1860.	1129.	46400.
INCHES		1.26	4.32	7.88	8.99
AC-FT		1074.	3690.	6722.	7673.

STATION 33, PLAN 1, RTIO 4

0.	0.	0.	0.	1.	3.	10.	29.	75.	167.
316.	491.	649.	683.	1062.	1088.	1102.	1054.	994.	932.
874.	819.	767.	718.	690.	683.	672.	656.	614.	530.
483.	448.	418.	392.	367.	344.	324.	304.	285.	267.
250.	234.	219.	205.	192.	180.	169.	158.	148.	138.
130.	122.	116.	110.	103.	97.	91.	85.	80.	75.
70.	66.	61.	58.	54.	50.	47.	44.	41.	39.
36.	34.	32.	30.	28.	26.	25.	23.	22.	20.
19.	18.	17.	16.	15.	14.	13.	12.	11.	10.
10.	9.	8.	6.	4.	2.	1.	1.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

STOR

0.	0.	0.	0.	0.	1.	3.	8.	20.	41.
67.	95.	123.	161.	183.	184.	185.	183.	181.	179.

177.	175.	173.	171.	168.	160.	148.	131.	113.	100.
93.	88.	83.	79.	75.	72.	68.	65.	61.	58.
55.	52.	50.	47.	45.	43.	41.	39.	37.	36.
34.	33.	31.	29.	27.	26.	24.	23.	21.	20.
19.	17.	16.	15.	14.	13.	13.	12.	11.	10.
10.	9.	8.	8.	7.	7.	7.	6.	6.	5.
5.	5.	4.	4.	4.	4.	3.	3.	3.	3.
3.	2.	2.	2.	1.	1.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1102.	1084.	899.	564.	23200.
INCHES		0.63	2.09	3.93	4.50
AC-FT		538.	1783.	3358.	3837.

STATION 33, PLAN 1, RTIO 5

0.	0.	0.	0.	1.	2.	5.	14.	37.	78.
140.	233.	321.	406.	475.	521.	541.	536.	515.	487.
458.	429.	402.	377.	353.	332.	312.	293.	274.	257.
240.	225.	211.	198.	185.	173.	162.	152.	142.	133.
125.	119.	112.	106.	100.	93.	88.	82.	77.	72.
67.	63.	59.	55.	52.	49.	46.	43.	40.	37.
35.	33.	31.	29.	27.	25.	24.	22.	21.	19.
18.	17.	16.	15.	14.	13.	12.	11.	11.	10.
9.	9.	8.	8.	7.	7.	6.	6.	6.	5.
5.	4.	4.	3.	2.	1.	1.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

STOR

0.	0.	0.	0.	0.	0.	1.	4.	10.	21.
36.	52.	68.	82.	92.	99.	102.	101.	98.	94.
89.	85.	81.	77.	73.	70.	66.	63.	59.	56.
54.	51.	48.	46.	44.	42.	40.	38.	36.	35.
33.	32.	30.	28.	26.	25.	23.	22.	20.	19.
18.	17.	16.	15.	14.	13.	12.	11.	11.	10.
9.	9.	8.	8.	7.	7.	6.	6.	6.	5.
5.	5.	4.	4.	4.	3.	3.	3.	3.	3.
3.	2.	2.	2.	2.	2.	2.	2.	1.	1.
1.	1.	1.	1.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	541.	532.	458.	282.	11600.
INCHES		0.31	1.07	1.96	2.25
AC-FT		264.	909.	1677.	1918.

PEAK FLOW SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS

			RATIOS APPLIED TO FLOWS				
OPERATION	STATION	PLAN	1.00	0.50	0.40	0.20	0.10
HYDROGRAPH AT	3	1	5517.	2759.	2207.	1103.	552.
		2	927.	0.	0.	0.	0.
ROUTED TO	33	1	5495.	2750.	2200.	1102.	541.
		2	927.	0.	0.	0.	0.